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COMPOSITAE

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ADAPTATION SYSTEMS IN *ARTEMISIA* SECTION *SERIPHIDIUM*

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Optimization of natural pasture vegetation resources is at present an urgent scientific problem which requires thorough investigation. Restoration of natural and creation of artificial, perennial highly productive pasture phytocoenosis is an important problem for Central Asia, which is the region of developed pasture livestock breeding. Towards this end it is necessary to select drought-resistant plants.

Adaptation is known to be a complex concept including all the signs which will ensure the survival of species under certain conditions.

Many scientific works are devoted to adaptation problems, e.g., Severtsev 1934, Shmalgausen 1940, Grant 1980, Vasilevskaya 1965, Oppenheimer 1960, Kozlowski 1970, Solbrig 1977, Genkel 1982, and others.

Species resistance can result from functional, structural or other biological particular features, for example, development cycle.

In this connection, systematic analysis was the main tool in our research of adaptation. We tried to present ecological relationships in the form of a diagram (Fig. 1) comprising the main components of an adaptation system (Rakhimova 1991).

The present work identifies the elements of adaptation of wormwood species to hot and arid environment and classifies adaptation systems in order to find the most draught-resistant ones.

The following species have been studied: *Artemisia ferganensis* H. Krasch., *A. sogdiana* Bunge, *A. tenuisecta* Nevski and *A. turanica* H. Krasch. Of these species *A. turanica* grows in Central Asia, Afghanistan and Iran, whereas the others grow only in Central Asia.

A. turanica is widely spread in deserts, specifically in Kizylkum, Muyunkum. The other three species are characteristic of foothills in the Tien-Shan and Pamir-Alai ranges.

Wormwood species are the main fodder plants on the pastures of the adir zone (foothill-semidesert zone). They form plant communities on grey and brown

desert soil covered with chippings, dominating on piedmont plains and foothill zone.

The study was carried out in the region of upland semidesert in Uzbekistan, Char-tak adirs (Fergana valley). *A. sogdiana* and *A. ferganensis* are widely spread on Fergana adirs, dominating in natural community. The other species were introduced by us.

The characteristic feature of climate in this zone is the strong manifestation of two seasons, viz. a mesothermal season (winter-spring) and a xerothermic one (summer), which has resulted in a complex set-up of plant adaptation features. The climate is continental, close to arid. Average temperature in July is 24-27°C, absolute maximum is 40-44°C. Average total precipitation of many years is 243 mm. Precipitation falls in winter-spring period. The soil is light and typically grey in colour. Altitude above sea-level is 780 m.

The studied wormwood species (subshrubs) belong to phenological type of spring-summer green plants (with half-rest in summer). Summer half-rest is noted to occur during the period of moisture deficiency. For example, on Fergana adirs summer half-rest is pronounced while under favourable conditions of Tashkent adirs (total precipitation is 477 mm) the plants are active the whole summer without reduction of evaporation surface, i.e. they are spring-summer-autumn green plants with a long vegetation period.

From the diagram it is seen that wormwood adaptation system is complex (Fig. 1). Their high viability under arid conditions is mainly the result of seasonal cycle, specific morphological structure of vegetative organs, and to a lesser extent adaptation affecting conservative anatomical and functional features. Fast swelling due to slimy pericarpium cells makes the seeds germinate after first autumn rain, the roots being formed before the cold period starts. The seed wall has a xeromorphic, isolateral-palisade structure, which allows it to function for a long period, say 1.5-2 months. Wormwood leaves are small and dissected, the mesophyll is thin, and the few water-carrying cells are placed only around the ribs. Water regime is labile. In spring transpiration rate is up to 1704 mgm/hr and 224-230 mgm/hr in summer. In spring water content of sprouts is 76.1-80.6%, and it reduces to 35.4-46.0% in summer.

Water-retaining ability is 40.5-56.8%, water deficiency reaches 57-63%. A pronounced period of summer half-rest, when assimilation processes come down to a minimum, speaks for instability of their water balance. Maximum heat resistance is 52-56°C. Photosynthetic activity in wormwoods is active in mezothermal period of the year; potential photosynthesis is 44-55 mgmCO₂/dm²/hr. Daily consumption of carbon dioxide is substantial (up to 400 mgm of CO₂/dm²/hr. However, photosynthesis and water regime are instable varying with ambience conditions. Adaptability of photosynthesis to high temperature and illumination intensity is limited: light saturation is observed within 40-50 * 10 lk, optimum

temperature zone is within 12-35°C. Critical respiration temperature is 47-50°C. The response of photosynthetic system is pronounced and photosynthesis intensity reduction reaches 55 mgm CO₂/dm²/hr.

Root system is not more than 2 m, and in summer water is saved due to sharp decrease in transpiration and increase in osmotic indices as well as decrease in evaporation surface (70-100% leaves fall).

Wormwoods of arid zone we call thermoixerophytes, i.e. xerophytes resting in summer, though the rest is relative, as wormwoods of arid zone have a distinctive feature - to slow down their functional and biological activity in xerothermic period, escaping unfavourable conditions (Rakhimova 1988). We conceive that the ability to throw off almost all leaves in summer is an important mechanism which helps survival during xerothermic period and which does not prevent normal development of reproduction organs. This feature is rather labile, its strength depending on soil draught.

The growth of water deficiency and respiration depression are pronounced and together with leaves fading can be considered as the main elements of morphophysiological transformation of the organism which together with osmotic indices provide viability in summer period.

Functional adaptation is expressed in sharp change in photosynthesis activity and water exchange level during vegetation: the most active physiological period is in the end of spring to beginning of summer, i.e. before soil draught.

The indication of adaptation of the indigenous species *A. ferganensis* and *A. sogdiana* to the draught is their ability to increase sucking force up to 48.0-58.5 atm in July and to 60 atm in September, while that of introduced species increases up to 45-47 atm by July, then the leaves fall. Indigenous species preserve their leaves longer in summer, and transpiration is more intense than in introduced species. This shows that in the summer period they are better provided with water. Introduced species in their natural location (light bedrock) have a poorer water-retaining ability than indigenous *Artemisia* species, as well as a shorter root system, and as a consequence leaf falling is more expressed (up to 100%).

Productivity of indigenous species amounts to more than 30-40 cent/hect. Wormwood phytocoenosis is more efficient in the regions where annual precipitation norm is more than 200 mm.

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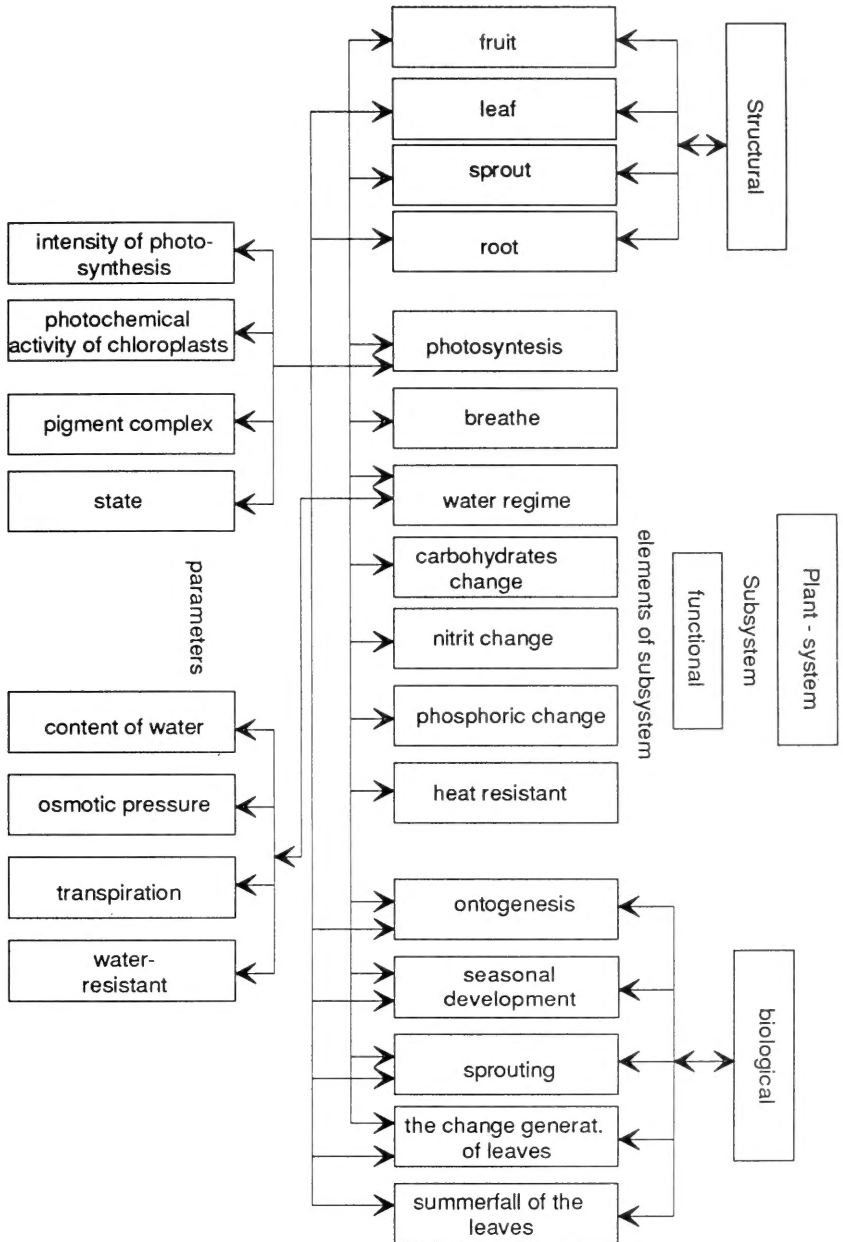


Fig. 1. The ecological correlation of main elements of adaptation system of plants in conditions of arid climate.

AUSTRALIAN COMPOSITAE

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Several years ago Bertil Nordenstam asked if I would write an article on Australian daisies, particularly outlining current research in the Australian Compositae. Despite my tardiness in replying to his request I believe that we can all benefit from general articles of this kind. Accordingly I have written an article, including some brief notes on the discovery of Australian daisies, which I hope will be of interest. I have also included a Table which details known chromosome numbers in Australian species. For genera mentioned in this Table I also supply references to the most recent taxonomic publications. In so doing I have virtually supplied readers of the *Newsletter* with a list of the most relevant taxonomic publications on Australian Compositae.

The first herbarium specimens of native Australian daisies to be gathered, a specimen of a *Brachyscome* and one of an *Olearia*, were collected in NW Australia in 1699 by William Dampier. They are now housed in the Sherardian Herbarium, Oxford. There was a considerable hiatus before daisies were again gathered from New Holland but serious exploratory trips in the late eighteenth and early nineteenth centuries saw much scientific activity along our shores, and that activity considerably increased when European settlers and visiting plant collectors began to scour the land after settlement in 1788. In 1867, Bentham, in his account of the family in *Flora australiensis*, recognised nearly 500 native species arranged in 88 genera. In compiling his treatment Bentham commented that 'with regard to genera, the large ones run into each other so much as to render it a more than usually difficult task to fix their limits, and the number of monotypic genera published has been most excessive; for the Australian flora alone I have ventured to propose the suppression of more than 80' (Bentham 1867, p. 448).

Following Bentham's treatment of the family, little work, and certainly no taxonomic revisions of genera or species complexes were carried out for about 70 years. New species were described but frequently they seem to have been attributed, with little serious thought about generic delimitation, to genera that were recognised by Bentham. This occurred despite comments by botanists such as Mueller (1889) and Ostenfeld (1921) that many of the genera reduced to synonymy by Bentham should be reinstated.

In the 1940s, revisionary work on some genera started. Gwenda Davis revised *Brachyscome* (Davis 1948) and subsequently *Lagenifera* (Davis 1950a), *Solenogyne* (Davis 1950b), *Calotis* (1952) and *Podolepis* (Davis 1957). In 1958, Nancy Burbidge published an account of the shrubby helichrysums (= *Ozothamnus*) and in 1960 Paul Wilson dealt with the *Helipterum albicans* complex (= *Leucochrysum*). Richard Schodde published a revision of *Millotia* in 1968. In 1965 Billie Turner ventured to our shores. During nearly two months of field work he determined chromosome numbers for many of our species, particularly those from semi-arid and arid environments (Turner 1967, 1970). As will be evident from the Table this survey still provides the bulk of our knowledge of chromosome numbers in the Gnaphalieae. Also in the '60s Spencer 'Spinnny' Smith-White, pioneer of plant karyological studies in Australia, also began to take an interest in the chromosomes of daisies. Smith-White discovered an as then undescribed species of *Brachyscome* (now known as *B. dichromosomatica*) with a haploid number of $n = 2$ (Smith-White 1968) and subsequently, along with students and associates such as Helen Stace, documented extensive aneuploidy and polyploidy in the genus (Smith-White *et al.* 1970). Detailed karyological investigations of the *B. lineariloba* (including *B. dichromosomatica*) complex were also carried out (e.g. Watanabe *et al.* 1976).

In the early to mid-1970s, work on the taxonomy and cytology of Australian Compositae gathered greater momentum. This in part reflects a general upturn in plant taxonomy in Australia, a situation helped in no small way by the establishment in 1973 of the Australian Biological Resources Study (a federal body funding taxonomic research) and the start of the *Flora of Australia* project in 1979. It perhaps also reflects the search by students for suitable taxonomic projects. In any case, a number of projects were initiated in the '70s and reached fruition in the late '70, and '80s. Thus, Laurie Adams published a review of *Solenogyne* (Adams 1979), Margaret Lawrence made extensive studies on the cytology and reproductive biology of Australian senecios for her Ph.D. (Lawrence 1980, 1985a), Nicholas Lander (PERTH) commenced taxonomic studies in Australian Astereae (e.g. Lander & Barry 1980a,b), Clyde Dunlop (DNA) published revisions of *Allopterigeron*, *Streptoglossa* and *Dichromochlamys* (Dunlop 1980, 1981a,b), Tony Orchard and Peter Copley investigated *Ixodia* (Orchard 1981, Copley 1982), the revision of *Vittadinia* by the late Nancy Burbidge was published (Burbidge 1982) and Helen Stace published papers on cytoevolution in *Calotis* (Stace 1978, 1982) and biosystematics of the *Brachyscome aculeata* complex (Stace 1981).

For a number of reasons I too was attracted to the Compositae in the '70s. In 1977 I was looking for a taxonomic project suitable for a Ph.D. Many projects came to mind but plant groups in which I was interested were invariably already claimed by other, active and not so active, taxonomists, or had been recently revised. Eventually it became apparent to me that there were few taxonomists with an

interest in the Compositae. Hence, since 1977, except for forays into botanical history, my research time has been almost exclusively spent working with daisies.

My initiation into the family began with studies of some compound-headed everlasting, in the '*Angianthus* group' of the Gnaphalieae, for my thesis. A revision of *Angianthus* (Short 1983) formed the major part of the thesis but I also documented pollen:ovule ratios for a number of gnaphalioid species, discovering outbreeding and inbreeding species pairs as a result of this work (Short 1981), and attempted to determine chromosome numbers for species not examined by Turner. The chromosome work proved to be difficult, field work in Western Australia in 1977 resulted in many collections of spirit material but in the lab I gained little more than a purple right thumb from staining and squashing anthers. When I did find them, the chromosomes were almost invariably 'sticky' and could not be reliably counted. I blame this on the lack of a refrigerator to keep specimens cool in the field. Certainly, in subsequent years, after keeping specimens refrigerated, I was successful in documenting aneuploidy in *Pogonolepis* and *Trichanthodium*. I may add that the Australian Gnaphalieae, as shown by both my own limited work and Turner's survey are prime candidates for consideration as subjects for cytoevolutionary studies, both aneuploidy and polyploidy being widely distributed. Cytological studies could also be of use in helping to unravel the problems of generic delimitation in the tribe.

Since 1977 I have published revisions of various gnaphalioid genera and have recently finalised a revision of *Millotia*. The revision should be published this year and will be accompanied by a separate paper, a cladistic analysis of the genus, a project carried out with Arne Anderberg (S). Arne and I also plan to collaborate with Paul Wilson (PERTH) on a cladistic analysis of the subtribe Angianthinae (*sensu* Anderberg) although because of various other commitments this project is unlikely to be completed very quickly. None the less, a lot of the work towards the project has been done. Apart from published revisions I have nearly completed work on *Calocephalus* and *Gnephosis* and have carried out preliminary work in *Asteridea*, and Paul has recently published major works on members of this group, including revisions of *Rhodanthe* (to which many species previously placed in *Helipterum* belong), *Waitzia*, and the *Lawrencella* complex (Wilson 1987, 1989a,b, 1992a-e).

Other botanists currently studying the Australian Gnaphalieae include Joy Everett (NSW), who is working on *Craspedia* and *Pycnosorus*, and Chris Puttock (CANB) who is revising *Ozothamnus* and *Cassinia*.

Partly because of an interest in cytoevolution, and partly because funding from ABRS was available for work in the genus *Brachyscome*, a few years ago I broadened my interest in the Compositae and received funding to begin working on this member of the Astereae. It was apparent from the work by Smith-White and his collaborators that Davis's earlier treatment (Davis 1948) had a number of

shortcomings. Although Davis had resolved a considerable number of nomenclatural and taxonomic matters, many species were poorly circumscribed and relationships not understood. I employed an assistant who was responsible for sectioning fruit of about 40 of the approximately 70 species currently considered to belong to the genus. Fruit from other native Astereae, including species of *Vittadinia*, *Calotis* and *Minuria* were also sectioned and it is evident that anatomical details of the fruit will be of considerable use in helping to decide generic limits within the tribe. For example there is considerable variation in the number of vascular bundles, the distribution of sclerenchyma, and the presence or absence of secretory canals in the pericarp. Hair types on the cypselas are also variable. My revisionary work on *Brachyscome* is slowly continuing and I currently plan to present some of my discoveries at the forthcoming Compositae Conference at Kew.

Initially I had intended carrying out cytological investigations within *Brachyscome* myself but soon after I began work on the genus, Professor Kuniake Watanabe of Kobe University, Japan, wrote to me and expressed interest in again taking up cytological investigations within the genus. Watanabe had worked with Smith-White in the early '70s and, as he is a cytologist, I readily agreed with his idea to collaborate on a biosystematic study of *Brachyscome*. More recently two Japanese students have begun molecular work on the genus. Yohei Suzuki is working on the RFLP of chloroplast DNA of *Brachyscome* and related genera and Tetsuo Denda is working on the comparison of DNA sequences of a nuclear gene of *Brachyscome*. Some of this work may also be presented at Kew.

Other botanists who have worked, or are currently working, on the Australian Astereae include Chris Quinn at The University of New South Wales. One of his students, using cladistics and making use of features of cypselas anatomy and morphology, has examined generic concepts in *Vittadinia s. lat.* and related taxa. In PERTH Nicholas Lander continues his studies of *Olearia* (Lander 1989, 1990, 1991) and related taxa.

The above synopsis is not exhaustive but I think should give a reasonable indication, particularly if combined with the information presented in the Table, of the cytological and taxonomic work that has been, and is being, carried out in the Australian Compositae. I might add that since Bentham's time, considerably more than 500 native species have been described for Australia. In a recent census of Australian vascular plants 831 native daisy species were listed under about 130 genera (Hnatiuk 1990), not 88 genera as recognised by Bentham (1867). The number of genera has subsequently increased further still (e.g. *Taplinia*, Lander 1989b) and I have little doubt that by the time the two volumes of the *Flora of Australia* dealing with the Compositae are published more than 150 genera will be recognised. The reason for this increase lies in part with the fact that many of the genera sunk by Bentham have been, or will be, reinstated; his contemporaries

such as Ferdinand Mueller, Asa Gray and Nicolai Turczaninow had generic concepts that are more in keeping with the ideas of today.

**Guide to chromosome numbers and relevant taxonomic literature
in Australian Compositae**

Taxon	n	2n	References
<u>Anthemideae</u>			
			Gadek <i>et al.</i> 1989; Bruhl & Quinn 1989
<u>Cotula L. (8)*</u>			
<i>C. cotuloides</i> (Steetz) Druce	18		Turner 1970
<u>Astereae</u>			
<u>Brachyscome Cass.(70)</u>			
			Davis 1948, 1949, 1955, 1959; Short 1988; Watanabe & Short 1992; Short & Watanabe 1993
<i>B. aculeata</i> (Labiil.) Cass. ex Lessing	9,18	18	Stace 1981
<i>B. aff. aculeata</i> (Mt Gingera)	9		Stace 1981
<i>B. aff. aculeata</i> (Halls Gap)	27		Stace 1981

* Number in brackets indicates approximate no. of Australian species currently recognised

<i>B. angustifolia</i> A.Cunn. ex DC.			
var. <i>angustifolia</i>	9		Smith-White <i>et al.</i> 1970
var. <i>heterophylla</i> (Benth.) G.L.R.Davis	9		Smith-White <i>et al.</i> 1970
<i>B. basaltica</i> F.Muell.			
var. <i>basaltica</i>	8	16	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
var. <i>gracilis</i> Benth.	6	12	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. bellidioides</i> Steetz	9		Turner 1970
<i>B. breviscapis</i> C.R.Carter	4	8	De Jong 1963; Smith-White <i>et al.</i> 1970; Carter 1978c; Watanabe & Short 1992
<i>B. campylocarpa</i> J.M.Black	5	10	Smith-White <i>et al.</i> 1970, as ' <i>B. campylocarpa</i> sp. B'; Watanabe & Short 1992
<i>B. cardiocarpa</i> F.Muell. ex Benth.	9		Smith-White <i>et al.</i> 1970
<i>B. cheilocarpa</i> F.Muell.	9		Carter 1978a
<i>B. chrysoglossa</i> F.Muell.	4	8	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. ciliaris</i> (Labill.) Less.	9,18, 27, 36I	27,36 81	De Jong 1963; Smith-White <i>et al.</i> 1970; Carter 1978a; Watanabe & Short 1992
<i>B. ciliocarpa</i> W.Fitzg.	9	18	Carter 1978a; Watanabe & Short 1992
<i>B. cuneifolia</i> Tate	9	18	Stace 1981
<i>B. curvicarpa</i> G.L.R.Davis	4	8	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. debilis</i> Sond.		6	Smith-White <i>et al.</i> 1970
<i>B. decipiens</i> Hook.f.	9,27	18,54	Solbrig <i>et al.</i> 1964; Smith- -White <i>et al.</i> 1970
<i>B. dentata</i> Gaudich.	4,8,12	8,16 24	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992

<i>B. dichromosomatica</i> C.R. Carter	2	4	Smith-White 1968, as <i>B. lineariloba</i> ; Smith-White <i>et al.</i> 1970, as ' <i>B. lineariloba</i> sp. A'; Smith-White & Carter 1970, as ' <i>B. lineariloba</i> sp. A'; Watanabe <i>et al.</i> 1975, as ' <i>B. lineariloba</i> race A'; Carter 1978b; Carter 1978c; Smith-White & Carter 1980; Watanabe <i>et al.</i> 1990; Watanabe & Short 1992
<i>B. dissectifolia</i> G.L.R.Davis	6	12	Smith-White <i>et al.</i> 1970
<i>B. diversifolia</i> (Hook.) Fischer & C. Meyer			
var. <i>dissecta</i> G.L.R. Davis	4	8	Smith-White <i>et al.</i> 1970
var. <i>diversifolia</i>	16 c.20	24	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. eriogona</i> (J.M.Black) G.L.R.Davis	4	8	Smith-White <i>et al.</i> 1970, as ' <i>B. campylocarpa</i> sp. A'; Watanabe & Short 1992
<i>B. exilis</i> Sond.	9		Carter 1978a
<i>B. formosa</i> P.S.Short	9		Short 1988
<i>B. goniocarpa</i> Sond. & F.Muell.	4	8	Watanabe <i>et al.</i> 1990; Watanabe & Short 1992
<i>B. gracilis</i> G.L.R.Davis		8	Watanabe & Short 1992
<i>B. graminea</i> (Labill.) F.Muell.	9	18	Smith-White <i>et al.</i> 1970
<i>B. halophila</i> P.S.Short	9		Short 1988
<i>B. iberidifolia</i> Benth.	9		De Jong 1963; Turner 1970; Carter 1978a; Keighery 1978
<i>B. latisquamea</i> F.Muell.	9		Carter 1978a
<i>B. leptocarpa</i> F.Muell.	3	6	Smith-White <i>et al.</i> 1970

<i>B. lineariloba</i> (DC.) Druce	6,8	10,12, 16	Smith-White 1968; Smith-White <i>et al.</i> 1970; Watanabe & Smith-White 1985, 1987; Watanabe & Short 1992
<i>B. lyrifolia</i> J.M.Black	9	18	Watanabe & Short 1992
<i>B. melanocarpa</i> Sond. & F.Muell.	6,12	12,30	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. microcarpa</i> F.Muell.	10	12	Smith-White <i>et al.</i> 1970
<i>B. muelleri</i> Sond.	3	6	Watanabe & Short 1992
<i>B. multifida</i> DC.			
var. <i>dilatata</i>	9	18	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
Benth.			
var. <i>multifida</i>	7	14	Smith-White <i>et al.</i> 1970
<i>B. nivalis</i> F.Muell.	11		Smith-White <i>et al.</i> 1970, excluding record of n = 9, re Stace 1981
<i>B. nodosa</i> P.S.Short & K.Watan.		6	Smith-White <i>et al.</i> 1970, as ' <i>B. goniocarpa</i> '; Watanabe & Short 1992, as ' <i>B. sp.</i> aff. <i>goniocarpa</i> '; Short & Watanabe 1993
<i>B. nova-anglica</i> G.L.R.Davis	6,7	12 14	Smith-White <i>et al.</i> 1970, a count of 3n = 18 is probably erroneous
<i>B. oncocarpa</i> Diels	9		Carter 1978a
<i>B. papillosa</i> G.L.R.Davis	4	8	Smith-White <i>et al.</i> 1970
<i>B. parvula</i> Hook.f.	9		Smith-White <i>et al.</i> 1970; Carter 1978a
<i>B. perpusilla</i> (Steetz) J.M.Black	9	18,36	Smith-White <i>et al.</i> 1970; Carter 1978a; Watanabe & Short 1992
<i>B. procumbens</i> G.L.R.Davis	9	18	Smith-White <i>et al.</i> 1970
<i>B. ptychocarpa</i> F.Muell.	6	12	Smith-White <i>et al.</i> 1970

<i>B. pusilla</i> Steetz	9	18	Carter 1978a
<i>B. radicans</i> Steetz	13	26	Smith-White <i>et al.</i> 1970
<i>B. rara</i> G.L.R. Davis	6	12	Watanabe & Short 1992
<i>B. readeri</i> G.L.R. Davis	5	10	Watanabe & Short 1992
<i>B. rigidula</i> (DC.) G.L.R. Davis	9		Smith-White <i>et al.</i> 1970; Carter 1978a; Watanabe & Short 1992
<i>B. riparia</i> G.L.R. Davis	9		Watanabe & Short 1992
<i>B. scapigera</i> (Sprengel)DC.	9	18	Smith-White <i>et al.</i> 1970;
<i>B. sieberi</i> DC.			
var. <i>gunnii</i> DC.	9		Stace 1981
<i>B. smithwhitei</i> P.S.Short & K.Watan.	3	6	Smith-White <i>et al.</i> 1970, as ' <i>B. campylocarpa</i> sp. C'; Watanabe & Short 1992, as ' <i>B. sp. aff.</i> <i>campylocarpa</i> '; Short & Watanabe 1993
<i>B. spathulata</i> Gaudich. subsp. <i>glabra</i> (DC.) Stace	9		Stace 1981
subsp. <i>spathulata</i>	9,18,27 36,45		Stace 1981
<i>B. stolonifera</i> G.L.R. Davis	15	30	Smith-White <i>et al.</i> 1970
<i>B. stuartii</i> Benth.	6	12	Smith-White <i>et al.</i> 1970
<i>B. tenuiscapa</i> Hook.f.			
var. <i>pubescens</i> (Benth.) G.L.R. Davis	9	18	Smith-White <i>et al.</i> 1970
<i>B. tesquorum</i> J.M.Black	9	18	Smith-White <i>et al.</i> 1970
<i>B. tetrapterocarpa</i> G.L.R. Davis	4	8	Watanabe & Short 1992
<i>B. trachycarpa</i> F.Muell.	27	36	De Jong 1963; Carter 1978a

<i>B. uliginosa</i> G.L.R.Davis	9		Smith-White <i>et al.</i> 1970
<i>B. whitei</i> G.L.R.Davis	5	10	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>Calotis</i> R.Br. (25)			Davis 1952; Stace 1978
<i>C. anthemoides</i> F.Muell.	7	14	Solbrig <i>et al.</i> 1964; Stace 1978
<i>C. ancyrocarpa</i> J.M.Black	4	8	Stace 1978
<i>C. cuneata</i> (F.Muell. ex Benth.) G.L.R.Davis	16	32	Stace 1978
<i>C. cuneifolia</i> R.Br.	8,16	16,32	Solbrig <i>et al.</i> 1964; Stace 1978
<i>C. cymbacantha</i> F.Muell.	7,14	28	Stace 1978
<i>C. dentex</i> R.Br.	8	16	Stace 1978
<i>C. erinacea</i> Steetz	7,14 21,28	14,28 56	Turner 1970; Stace 1978
<i>C. hispidula</i> (F.Muell.) F.Muell.		16	Stace 1978
<i>C. inermis</i> Maiden & Betche	8	16	Stace 1978
<i>C. glandulosa</i> F.Muell.	8	16	Stace 1978
<i>C. lappulacea</i> Benth.	14		Stace 1978
<i>C. latiuscula</i> F.Muell. & Tate	7,14 28	14,21	Stace 1978, 1982
<i>C. multicaulis</i> (Turcz.) Druce	4,8	8,16	Turner 1970; Stace 1978, as <i>C. multicaulis</i> sp. B
<i>C. plumifera</i> F.Muell.	5	10,20	Stace 1978, as <i>C. multicaulis</i> sp. B
<i>C. porphyroglossa</i> F.Muell.	10	20	Stace 1978
<i>C. scabiosifolia</i> Sond. & F.Muell.			
var. <i>integrifolia</i> F.Muell. ex Benth.	8,16	16,32	Stace 1978

var. <i>scabiosifolia</i>	8,16	16,32	Stace 1978
<i>C. scapigera</i> Hook.	8,16		Stace 1982
<i>C. squamigera</i> C.T.White		16	Stace 1978
<i>C. xanthosoidea</i> Domin	8	16	Stace 1978
<i>Celmisia</i> Cass. (10)			Given & Gray 1986
<i>C. asteliifolia</i> Hook. f. complex	54, 108	108, 216	Hair 1980
<i>C. longifolia</i> Cass. complex	54, 108	108	Hair 1980
<i>C. sericophylla</i> J.H.Wills		108	Hair 1980
<i>Ceratogyne</i> Turcz. (1)			Gadek <i>et al.</i> 1989
<i>C. obionoides</i> Turcz.	6		Turner 1970
<i>Erodiophyllum</i> F.Muell. (2)			
<i>E. acanthocephalum</i> Stapf	8		Solbrig <i>et al.</i> 1964
<i>Isoetopsis</i> Turcz. (1)			Bruhl & Quinn 1990
<i>I. graminifolia</i> Turcz.	17		Turner 1970
<i>Kippistia</i> F.Muell. (1)			Lander & Barry 1980a
<i>K. suaedifolia</i> F.Muell.	9		Short 1986a
<i>Lagenifera</i> Cass. (4)			Davis 1950a; Cabrera 1966
<i>L. huegelii</i> Benth.	9		Turner 1970

<i>L. stipitata</i> (Labill.) Druce	9		Smith-White <i>et al.</i> 1970
Minuria DC. (10)			Lander & Barry 1980b; Lander 1987b; Short 1991
<i>M. cunninghamii</i> (DC.) Benth.	9	18	Turner 1970
<i>M. leptophylla</i> DC	9		Turner 1970; Short 1986a
Olearia Moench (100)			Lander 1989a, 1990, 1991
<i>O. adenolasia</i> F.Muell.	9		Turner 1970
<i>O. algida</i> N.A.Wakef.		18	Beuzenberg & Hair 1984
<i>O. argophylla</i> F.Muell.	54		Solbrig <i>et al.</i> 1964
<i>O. astroloba</i> Lander & N.G. Walsh	9		Short in Lander & Walsh 1989
<i>O. axillaris</i> (DC.) F.Muell. ex Benth.	9		Solbrig <i>et al.</i> 1964
<i>O. ciliata</i> (Benth.) F.Muell. ex Benth.	9		Turner 1970
<i>O. frostii</i> (F.Muell.) J.H. Willis		18	Beuzenberg & Hair 1984
<i>O. humilis</i> Lander	9		Turner 1970, as <i>Olearia</i> sp.; Short in Lander 1989
<i>O. muelleri</i> (Sond.) Benth.	9		Turner 1970
<i>O. pannosa</i> Hook.		90	Beuzenberg & Hair 1984
<i>O. phlogopappa</i> (Labill.) DC. complex	9		Solbrig <i>et al.</i> 1964
<i>O. pimelioides</i> (DC.) Benth.	9		Turner 1970, and as <i>O. propinqua</i>
<i>O. rudis</i> (Benth.) Benth.	9		Turner 1970
<i>O. stuartii</i> (F. Muell.) F. Muell. ex. Benth.	9		Short in Lander 1989

Solenogyne Cass. (3)			Davis 1950b; Adams 1979
<i>S. bellioides</i> Cass.	9		Smith-White <i>et al.</i> 1970; Adams 1979
<i>S. dominii</i> L.G.Adams	9	18	Adams 1979
<i>S. gunnii</i> (Hook.f.) Cabrera	9		Adams 1979
Vittadinia A.Rich. (40)			Burbidge 1982; Lander 1987a
<i>V. dissecta</i> (Benth.) N.T.Burb.			
var. <i>hirta</i> N.T.Burb.	9		Turner 1970, as <i>V. triloba</i> & <i>Vittadinia</i> sp.
Gnaphalieae			Anderberg 1991
Actinobole Fenzl ex Endl. (4)			Short 1985
<i>A. drummondiana</i> P.S.Short	10		Turner 1970, as <i>Gnaphalodes</i> <i>condensatum</i>
<i>A. uliginosum</i> (A. Gray) H. Eichler	c. 11		Short 1985
Angianthus Wendl. (16)			Short 1983, 1990b
<i>A. milnei</i> Benth.	13		Turner 1970, as <i>A. tomentosus</i>
<i>A. tomentosus</i> Wendl.	12		Turner 1970
Argentipallium Paul G. Wilson (6)			Wilson 1992d
<i>A. niveum</i> (Steetz) Paul G. Wilson	12		Turner 1970, as <i>Helipterum obtusifolium</i>

Asteridea Lindley (9)

A. athrixioides (Sond. & F.Muell.) Kroner 9 Turner 1970, as *Athrixia athrixioides*; Short 1986a

Bellida Ewart (1/1)

B. graminea Ewart 9 Wilson 1992a
Turner 1970

Blennospora A. Gray (2/2)

B. drummondii A. Gray 22 Short 1987b

B. phlegmatocarpa (Diels) P.S.Short 11 22 Short 1987b

Bracteantha Anderb. & Haegi (5+)

B. bracteata (Vent.) Anderb. & Haegi 14 Turner 1970

Calocephalus (14)

C. francisii Benth. c. 14 Turner 1970

Cephalipterum A. Gray (1)

C. drummondii A. Gray 12, 14 Turner 1970

Chrysocephalum Walp. (10+)

C. apiculatum (Labill.) Steetz complex 12, c. 38 Anderberg 1991
Turner 1970, as *Helichrysum apiculatum*

<i>C. semicalvum</i> (F.Muell.) Paul G. Wilson	c. 38 c.40I	Turner 1970, as <i>Leptorhynchus ambiguus</i>
Craspedia (20+)		Everett & Doust 1992; Everett & Thompson 1992
<i>C. uniflora</i> Forst. <i>s. lat.</i>	11, 70+	Turner 1970
Gilberta Turcz. (1)		Wilson 1992b
<i>G. tenuifolia</i> Turcz.	c. 10	Turner 1970, as <i>Myriocephalus gracilis</i>
Gnephosis Cass. <i>s. str.</i> (6)		Short 1983, 1987a
<i>G. multiflora</i> (P.S.Short) P.S.Short	c. 24	Short 1983, as <i>Chrysocoryne</i> <i>multiflora</i>
<i>G. tenuissima</i> Cass.	6	12 Short 1983, as <i>Chrysocoryne</i> <i>pusilla</i>
<i>G. tridens</i> (P.S.Short) P.S.Short		26 Short 1983, as <i>Chrysocoryne</i> <i>tridens</i>
<i>G. trifida</i> (P.S.Short) P.S.Short		c. 22 Short 1983, as <i>Chrysocoryne</i> <i>trifida</i>
Gnephosis <i>s. lat.</i>		
<i>G. gynotricha</i> Diels	12	Turner 1970
Haptotrichion Paul G. Wilson (2)		Wilson 1992b
<i>H. conicum</i> (B.L.Turner) Paul G. Wilson	12	Turner 1966, 1970, as <i>Waizia</i> <i>conica</i>
Hyalosperma Steetz (5/9)		Wilson 1989a

<i>H. cotula</i> (Benth.) Paul G. Wilson	12	Turner 1970, as <i>Helipterum cotula</i>
<i>H. glutinosum</i> Steetz subsp. <i>glutinosum</i>	11	Turner 5339 (cited in Wilson 1989a)
<i>H. semisterile</i> (F. Muell.) Paul G. Wilson	7 or 8	Turner 1970, as <i>Helipterum jessenii</i>
<i>H. simplex</i> (Steetz) Paul G. Wilson		
subsp. <i>graniticola</i> Paul G. Wilson	11	Turner 5499 (cited in Wilson 1989a)
<i>H. zacchaeus</i> (S. Moore) Paul G. Wilson	8	Turner 1970, as <i>Helipterum guilfoylei</i>
<i>Ixiolaena</i> Benth. (8)		Short <i>et al.</i> 1989
<i>I. leptolepis</i> (DC.) Benth.	c. 21	Turner 1970
<i>Ixodia</i> R.Br. (2)		Orchard 1981; Copley 1982
<i>I. achillaeoides</i> R.Br. subsp. <i>achillaeoides</i>	13	Copley 1982
<i>Lawrencella</i> Lindley (2)		Wilson 1992a
<i>L. davenportii</i> (F. Muell.) Paul G. Wilson	11	Turner 1970, as <i>Helichrysum davenportii</i>
<i>L. rosea</i> Lindley	8	Turner 1970, as <i>Helichrysum lindleyi</i>
<i>Leptorhynchos</i> Less. (10)		
<i>L. waitzia</i> Sond.	12	Turner 1970

Leucophyta R. Br.(1)		
<i>L. brownii</i> Cass.	9	Short 1986a
Millotia Cass. (11)		
<i>M. depauperata</i> Stapf	8	Schodde 1968, as <i>M. inopinata</i> ; Turner 1970, as ' <i>M. cassini</i> '
<i>M. myosotidifolia</i> (Benth.) Steetz	10, 11	Turner 1970
<i>M. tenuifolia</i> Cass.	13	Turner 1970
Podolepis Labill. (15)		
<i>P. arachnoidea</i> (Hook.) Druce	9	Davis 1957; Short <i>et al.</i> 1989 Turner 1967
<i>P. auriculata</i> DC.	11	Turner 1967
<i>P. canescens</i> Cunn. ex DC.	10	Turner 1967; Short 1986a
<i>P. capillaris</i> (Steetz)Diels	3	Turner 1970; Keighery 1978; Short 1986a
<i>P. gardneri</i> G.L.R.Davis	8	Turner 1967
<i>P. jaceoides</i> (Sims) Voss	c. 30	Turner 1967
<i>P. kendallii</i> (F.Muell.) F.Muell.	11	Turner 1967
<i>P. lessonii</i> (Cass.)Benth.	7	Turner 1970
<i>P. neglecta</i> G.L.R.Davis	10	Turner 1967
<i>P. microcephala</i> Benth.	12	Turner 1970
<i>P. monticola</i> R.J.H.Hend.	10	Henderson 1969
<i>P. rugata</i> Labill.	10	Turner 1967
<i>P. tepperi</i> (F.Muell.) D.A.Cooke	8	Turner 1970, as <i>Helichrysum tepperi</i>

Podotheca Cass. (6)		Short 1989
<i>P. angustifolia</i> (Labill.)Less.	13, c. 26	Turner 1970
<i>P. gnaphalioides</i> Grah.	c. 13	Turner 1970
<i>P. chrysantha</i> (Steetz) Benth.	13	Turner 1970
Pogonolepis Steetz (2)		Short 1986b
<i>P. muelleriana</i> (Sond.) P.S.Short		12 Short 1986b c. 20 c. 24
<i>P. stricta</i> Steetz	4	8, 10 Short 1986b
Polycalymma Benth. (3)		Wilson 1987
' <i>P. craspedioides</i> '	8	Turner 1970, as <i>Helipterum craspedioides</i>
' <i>P. guerinae</i> '	8	Turner 1970, as <i>Myriocephalus guerinae</i>
Pycnosorus Benth. (6)		Everett & Doust 1992
<i>P. pleiocephalus</i> (F.Muell.) Everett & Doust	6	Short 1986a, as <i>Craspedia pleiocephala</i>
Quinetia Cass. (1)		
<i>Q. urvillei</i> Cass.	c. 12	Turner 1970
Rhodanthe Lindley (44)		Wilson 1992b
sect. Achyroclinoides (10)		
<i>R. haigii</i> (F.Muell.) Paul G. Wilson	8	Turner 1970, as <i>Helipterum</i> <i>haigii</i>

<i>R. psammophila</i> Paul G. Wilson	5	Turner 1970, as <i>Helipterum condensatum</i>
<i>R. tietkensis</i> (F. Muell.) Paul G. Wilson	8	Turner 1970, as <i>Helipterum tietkensis</i>
sect. <i>Helichrysoides</i> (4)		
<i>R. battii</i> (F. Muell.) Paul G. Wilson	10	Turner 1970, ? as <i>Helip- terum cf. battii</i> ; Wilson 1992b
<i>R. pollackii</i> (F. Muell.) Paul G. Wilson	10	Wilson 1992b
<i>R. spicata</i> (Steetz) Paul G. Wilson	10	Turner 1970, as <i>Helipterum spicatum</i> ; Wilson 1992b
sect. <i>Leiochrysum</i> (17)		
<i>R. chlorocephala</i> (Turcz.) Paul G. Wilson		
subsp. <i>rosea</i> (Hook.) Paul G. Wilson	7, 14	Turner 1970, as <i>Helipterum roseum</i>
subsp. <i>splendida</i> (Hemsley) Paul G. Wilson	7	Turner 1970, as <i>Helipterum splendidum</i>
<i>R. humboldtiana</i> (Gaudich.) Paul G. Wilson	8	Turner 1970, as <i>Helipterum humboldtianum</i>
<i>R. oppositifolia</i> (S. Moore) Paul G. Wilson	11	Turner 1970, as <i>Helipterum oppositifolium</i>
<i>R. polygalifolia</i> (A. Cunn. ex DC.) Paul G. Wilson	11	Turner 1970, as <i>Helipterum polygalifolium</i>
<i>R. pygmaea</i> (DC.) Paul G. Wilson	11	Turner 1970, as <i>Helipterum pygmaeus</i>
<i>R. rubella</i> (A. Gray) Paul G. Wilson	14	Turner 1970, as <i>Helipterum rubellum</i>
<i>R. stricta</i> (Lindley) Paul G. Wilson	11	Turner 1970, as <i>Helipterum strictum</i>
sect. <i>Monencyanthes</i> (3)		

<i>R. maryonii</i> (S. Moore) Paul G. Wilson	5	Turner 1970, as <i>Helipterum maryanii</i>
sect. Rhodanthe (1)		
<i>R. manglesii</i> Lindley	11	Turner 1970, as <i>Helipterum manglesii</i>
sect. Synachyrum (5)		
<i>R. stuartiana</i> (Sond.) Paul G. Wilson	10	Turner 1970, as <i>Helipterum stuartianum</i>
Schoenia Steetz (5)		Wilson 1992a
<i>S. cassiniana</i> (Gaudich.) Steetz	12	Turner 1970
Triptilodiscus Turcz. (1)		Wilson 1992b
<i>T. pygmaeus</i> Turcz.	c. 12	Turner 1970, as <i>Helipterum australe</i>
Trichanthodium Sond. & F.Muell. (4)		Short 1990a
<i>T. baracchianum</i> (Ewart & Jean White) P.S.Short	3	Short 1970
<i>T. exilis</i> (W.V.Fitzg.) P.S.Short	3	Short 1990a
<i>T. scarlettianum</i> P.S.Short	3,7	Turner 1970, as ' <i>Calocephalus skirrhophora</i> '; Short 1990a
<i>T. skirrhophorum</i> Sond. & F.Muell.	4	Turner 1970, as <i>Gnephosis skirrhophora</i> ; Short 1990a
Waitzia J.C.Wendl. (5)		Wilson 1992e
<i>W. nitida</i> (Lindley) Paul G. Wilson	10	Turner 1970, as <i>W. aurea</i>

<i>W. suaveolens</i> (Benth.) Druce	12		Turner 1970
Plucheae			
<i>Streptoglossa</i> Steetz (8)			Dunlop 1981a
<i>S. liatroides</i> (Turcz.) Dunlop	10		Turner 1970, as <i>Pterigeron liatroides</i>
Senecioneae			
<i>Abrotanella</i> Cass. (3)			Nordenstam 1978
<i>A. forsterioides</i> (Hook.f) Benth.		36	Beuzenberg & Hair 1984
<i>A. scapigera</i> (F.Muell.) Benth.		18	Beuzenberg & Hair 1984
Bedfordia DC. (3)			
<i>B. salicina</i> (Labill.) DC.	30		Ornduff <i>et al.</i> 1963
Senecio L. (50)			
Radiate species			
<i>S. glossanthus</i> (Sond.) Belcher	20	40	Turner 1970, also as <i>S.</i> <i>brachyglossus</i> ; Lawrence 1980
<i>S. gregorii</i> F.Muell.	20	40	Ornduff <i>et al.</i> 1963; Turner 1970; Lawrence 1980
<i>S. lautus</i> Forst.f. ex Willd. complex	20	40	Turner 1970; Lawrence 1980

<i>S. linearifolius</i> A.Rich.	30	60	Lawrence 1980
<i>S. macranthus</i> A.Rich.	20	40	Lawrence 1980
<i>S. magnificus</i> F.Muell.	20	40	Lawrence 1980
<i>S. orarius</i> J.M.Black		70	Lawrence 1980
<i>S. pectinatus</i> DC.	40	80	Lawrence 1980
<i>S. spathulatus</i> A.Rich.	20	40	Lawrence 1980
<i>S. vagus</i> F.Muell.			
subsp. <i>eglandulosus</i>	49	98	Lawrence 1980
Ali			
<i>S. vellioides</i> A.Cunn. ex DC.	19	38	Lawrence 1980
Discoid species			
<i>S. anethifolius</i> A.Cunn. ex DC.	30	60	Turner 1970; Lawrence 1980
<i>S. cunninghamii</i> DC.			
var. <i>cunninghamii</i>	30	60	Lawrence 1980, as 'form 1 (typical)'
var. <i>serratus</i> M.E.Lawr.	30	60	Lawrence 1980, as 'form 2'; Lawrence 1985
<i>S. gawlerensis</i> M.E.Lawr.	30	60	Lawrence 1980, as <i>S. georgianus</i> var. <i>latifolius</i> ; Lawrence 1985
<i>S. hypoleucus</i> F.Muell. ex Benth.	30	60	Lawrence 1980
<i>S. odoratus</i> Hornem.			
var. <i>longifolius</i> M.E.Lawr.	30	60	Lawrence 1980, as <i>S.</i> <i>odoratus</i> var. 'A'; Lawrence 1985
var. <i>obtusifolius</i> J.M.Black	30	60	Lawrence 1980
var. <i>odoratus</i>	30	60	Lawrence 1980

Erechthitoid species

<i>S. bipinnatisectus</i> Belcher		60	Lawrence 1980
<i>S. biserratus</i> Belcher	50	100	Lawrence 1980
<i>S. diaschides</i> Drury	30	60	Lawrence 1980, as species 'B'
<i>S. glomeratus</i> Desf. ex Poir.	30	60	Lawrence 1980
<i>S. gunnii</i> (Hook.f.) Belcher	20	40	Lawrence 1980
<i>S. hispidulus</i> A.Rich.			
var. <i>dissectus</i> (Benth.) Belcher	30	60	Lawrence 1980
var. <i>hispidulus</i>	30	60	Lawrence 1980
<i>S. minimus</i> Poir.	30	60	Ornduff <i>et al.</i> 1963; Lawrence 1980
<i>S. picridioides</i> (Turcz.) M.E.Lawr.	30	60	Lawrence 1980, as <i>S.</i> <i>minimus</i> var. <i>picridioides</i> ; Lawrence 1985
<i>S. quadridentatus</i> Labill.	20	40	Lawrence 1980
<i>S. squarrosus</i> A.Rich.	30	60	Lawrence 1980

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THE FATE OF *SHEARERIA* S. MOORE (ASTEREAEE) IN BREMER'S ASTERACEAE BOOK

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Since I feel somewhat responsible for the lack of an old genus, i.e. *Sheareria* S. Moore, in Bremer's Asteraceae book (Bremer 1994), I will here explain why the genus was not included.

In 1875 Spencer Moore described a number of flowering plants collected by Shearer in China (Moore 1875). Among them was a species of Asteraceae which Moore described as a new genus *Sheareria*, hence honouring the species' first European discoverer. Moore (1875) placed the single species, *Sheareria nana*, in the Astereae, mentioning that it was closely related to *Rhynchospermum*, another South East Asian member of the Astereae.

Subsequently, Hoffmann (1890) placed *Sheareria* in the Heliantheae-Milleriinae, a subtribe diagnosed at this point as small-headed Heliantheae with mostly functionally male disc florets. Among these were *Tetranthus*, *Pinillosia*, and their putative close relatives (Karis & Ryding 1994), as well as *Clibadium*. *Sheareria* differed with, for example, its alternate leaves. Interestingly, Hoffmann stated that George Bentham favoured a position of *Sheareria* in the Heliantheae-Milleriinae, rather than in the Astereae. However, Bentham must have passed this information personally directly to Hoffmann, because the plant was described two years after Bentham's large Asteraceae contributions (Bentham 1873a, b). It might also be possible that Bentham wrote his standpoint directly on the herbarium sheets, and that Hoffmann later adopted Bentham's view.

Sheareria remained in the Heliantheae during many decades, although it was treated under Milleriinae with much doubt by Stuessy (1977), when he wrote his account of the Heliantheae in the Reading Compositae volumes. It is also found under Heliantheae in the more recent Chinese floras (Yi-Ling 1979).

When I embarked on my Heliantheae study (Karis 1993), I used Robinson's 1981 paper as a base. I quickly got the impression that Robinson's circumscription of the Heliantheae *sensu lato* probably comprises a monophyletic group, hence containing all the taxa that Nordenstam (1977) suggested to leave the Senecioneae

for the Heliantheae *sensu lato*, and also many taxa still accepted by Stuessy (1977), though in many cases with doubt, or such taxa that even were suggested by Stuessy to be dismissed from the Heliantheae (e. g. *Coulterella*, *Marshallia*, *Tetranthus*). Only a few terminals included by me (Karis 1993) stem from more recent work in the tribe (Eriksson 1990, 1991, Strother 1991), or is lacking in Robinson (1981), i. e. *Chaetymenia* (B. L. Turner pers. comm. 1991).

Robinson (1981: 25) simply stated, without a more thorough discussion, that *Sheareria* belong in the Astereae, together with other taxa treated with doubt by Stuessy in his Heliantheae chapter (for example, *Olearia*). As I felt confident about Robinson's circumscription of the tribe as being monophyletic, there were no reasons to look closer at any of the genera he suggested to belong to other tribes. Consequently, it was also overlooked by Zhang & Bremer and is missing in Bremer's book.

I have not seen material of *Sheareria* (there is none in S), but it is clear from the illustrations I have seen (the protologue and in the Chinese floras) that it belongs in the Astereae (see also Nesom 1994). But, unfortunately, it is lacking in the Asteraceae book (Bremer 1994), and in Zhang's and Bremer's (Zhang & Bremer 1993) tribal cladistic analysis.

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VEGETATIVE REGENERATION STUDIES OF *CHROMOLAENA ODORATA* (L.) K. & R.

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Abstract

Vegetative regeneration studies from rhizomes of *Chromolaena odorata* (L.) K. & R. and the different water regimes and soils have been carried out. Three and six day intervals of irrigation and garden soil (pH 5.8) were found to be ideal for regeneration, plant height and leaf area.

Introduction

Chromolaena odorata (L.) K. & R. is a prominent feature of vegetation in ferrosols and ferruginous tropical soil regions of Nigeria. It is commonly found along roadsides, in abandoned farmlands and waste places. Recently it has become a problematic weed in plantations and arable crops (Eze & Gill 1992) and it is spreading fast towards the northern parts of the country with lithosols, even though this has not been recorded as such to occur in that region. One of the obvious reasons for this spread is its ability to reproduce both sexually and asexually. In some African countries it is allowed to grow for some time to improve the fertility of the soil.

Chromolaena odorata has long, stout, branched rhizomes which sprout profusely on the advent of the rainy-season, sometimes forming impregnable bushy thickets up to 2 m tall.

From a perusal of literature, it is apparent that information is not forthcoming on its vegetative regeneration capacity and effect of soil types on its regeneration.

The present study is undertaken with the following objectives, (a) to investigate vegetative regeneration in different soil types; and (b) to look at the effect of water regimes on regeneration capacity.

Materials and Methods

Rhizomes were cut into 10 cm lengths and were placed in plastic pots containing pure sand (pH 7.5) and ordinary garden soil (pH 5.8). There were six treatments for each set of rhizomes and each of these was replicated thrice.

The treatments were as follows: (i) no watering throughout the duration of the experiment, (ii) daily watering, (iii) watering after three days, six days, nine days and twelve days interval. The pots were set outside in a partial shade in a completely randomized block design. Regeneration was noted when the shoot emerged from the stump. The characteristics of regeneration such as plant height from the stump, leaf number and leaf area were measured following Eze (1965).

Results

Data obtained were statistically analysed using Analysis of variance. The results of the present study are shown in Table 1, 2, and 3.

From these Tables, it is apparent that regeneration capacity of fragments of the rhizome of *C. odorata* is appreciably higher in ordinary garden soil than in pure sand. The mean height of the plants was $19.6 \text{ cm} \pm 3$ when the plants were irrigated at 6 day interval and the number of leaves was 69 ± 9 . This value for height of plant was found to be significantly higher than that of control (no watering, being $9.6 \text{ cm} \pm 5$) at $p = 0.01$. However, in sandy soil the height of plants was $6.6 \text{ cm} \pm 3$ when plants were irrigated daily and the number of leaves were 17 ± 8 . There was no regeneration in other water regimes.

The leaf area is seen to be affected by the water regime as plants irrigated at 3 day interval had a mean leaf area of $15 \text{ cm}^2 \pm 5$. This value is significantly higher than that of control (no watering; $8.0 \text{ cm}^2 \pm 2$) at $p = 0.05$. There was, however, no significant difference between the mean leaf area for plants watered every three days ($15.2 \text{ cm}^2 \pm 5$) and those irrigated at six days interval ($13.0 \text{ cm}^2 \pm 3$). The leaf area of plants grown in sand and watered daily was $9.2 \text{ cm}^2 \pm 1$. The plant height, number of leaves and leaf area of rhizome grown in ordinary soil and watered at three day interval are not statistically different from those watered at six days interval.

Discussion

Unlike regeneration of temperate plants, which is likely to take place in the spring (e.g. Lubke & Carvers 1970), the regeneration of *C. odorata* takes place throughout the year though more pronounced during the dry season (October to November).

The results obtained in the present study are in agreement with the natural conditions prevailing during the dry season with occasional rainfall and dew drops at night. This shows that the plant does not require daily watering to regenerate. This may be due to the fact that the rhizomes had sufficient food materials to trigger off the regeneration of rhizome segment in comparatively drier ferrosols. The poor regeneration in sandy soils shows the reason for the absence of this plant on sandy banks of the rivers and streams and lithosol regions in Nigeria. Hudson (1955) showed that many plant species regenerate readily from rhizome cuttings at any season, while others are strictly seasonal in their regeneration (e.g. *Populus nigra* and *Phlox paniculata*).

From the present study it is apparent that time of collection had no obvious effect on the regeneration capacity of the rhizomes of *C. odorata*. The spreading rhizomatous habit of the underground systems of *C. odorata* apparently makes it a good species for binding and stabilizing the soil and this is one reason why it is so successful as a colonizer of open waste places.

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Table 1. Height of *C. odorata* plants from rhizomes after 35 days of exposure to different water regimes in ordinary garden soil (A) and sand (B).

A

Watering interval	Height, cm
0	9.6 ± 5
daily	15.6 ± 2
3 day	18.0 ± 2
6 day	19.6 ± 3
9 day	11.6 ± 4
12 day	0

B

Watering interval	Height, cm
0	0
daily	6.6 ± 3
3 day	0
6 day	0
9 day	0
12 day	0

Table 2. Leaf number of *C. odorata* rhizome after 35 days of exposure to different water regimes in ordinary garden soil (A) and sand (B).

A

Watering interval	Leaf number
0	8.6 ± 1
daily	44.0 ± 5
3 day	64.6 ± 12
6 day	68.6 ± 9
9 day	45.3 ± 23
12 day	5.3 ± 3

B

Watering interval	Leaf number
0	1.3 + 1
daily	17.3 ± 8
3 day	0
6 day	0
9 day	0
12 day	0

Table 3. Leaf area of *C. odorata* grown from rhizomes exposed to different water regimes for 35 days in ordinary garden soil (A) and sand (B).

A

Watering interval	Leaf area, cm ²
0	8.0 ± 2
daily	11.2 ± 3
3 day	15.2 ± 5
6 day	12.9 ± 3
9 day	6.2 ± 5
12 day	1.6 -

B

Watering interval	Leaf area, cm ²
0	0
daily	9.2 ± 1
3 day	0
6 day	0
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NEW SYNONYMS AND NOTES ON *BIDENS* OF AFRICA

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Abstract

New synonyms for recently published taxa within *Bidens* are provided. *B. gledhillii* T.G.J. Rayner (1993) is synonymous with *B. sierra-leonensis* Mesfin. The subspecific taxa within *B. diversa*, erected by Rayner (1993) based primarily on overlapping differences on the shape and the apical incisions of the ray florets, are untenable.

Introduction

In his worldwide revision of *Bidens*, Sherff (1937) recognized 233 species with a large number of varieties and forms. For Africa alone, a total of 82 species were recorded. Forty-seven of the "species" have since been relegated to synonymy (Cufodontis 1967; Wild 1967; Mesfin 1993). Likewise, on the basis of hybridization and biosystematic studies, Ganders & Nagata (1983) reduced the number of species of *Bidens* in Hawaii to 19 from the previously reported number of 43 species with 20 varieties (Sherff 1937). Some of these species, when initially described by Sherff (1937) were based on one or a few specimens. Now with the accumulation of a large number of specimens in herbaria, it has become possible to ascertain the limits between the species on morphological grounds. Sometimes also, as in the case of the Hawaiian *Bidens*, species have been delimited on experimental grounds. Sherff also erected many species on the basis of leaf forms and minor differences in achenial features which are extremely variable within and among populations.

Since the last monograph on the genus (Sherff 1937), a number of new species of *Bidens* have been published, e.g. Cufodontis (1943), Ganders & Nagata (1983), Mesfin (1983, 1984, 1989, 1993), Lisowski (1987, fide Mesfin 1993), Anderberg (1988, fide Mesfin 1993), etc. And although no worldwide revision of the genus

employing modern techniques and approaches and more reliable (sensu Davis & Heywood 1963) characters is available, an account of the species occurring in Africa based on differential and co-varying morphological features has just been published (Mesfin 1993).

The recognition of infraspecific taxa based on especially minor qualitative and quantitative differences in foliar and/or capitular morphology solely from herbarium specimens has often been found to be quite untenable. **It is advisable to understand the variation within and among populations, preferably observed in field studies, before erecting infraspecific units.** In this respect, we find the taxonomic approaches of Gillett (1975) and Ganders & Nagata (1984), on Hawaiian *Bidens*, Smith (1973, 1976, 1984) and Crawford (1970, 1971), on North American *Coreopsis*, in resolving inter- and intra-specific taxonomic problems instructive. Until this is attempted, the validity and taxonomic utility of many named infra-specific units will all be in question and of no or very little practical significance. Consequently, we have proposed the following for those infra-specific units of *Bidens* which have continued to proliferate.

Taxonomic notes

Bidens sierra-leonensis Mesfin, Kew Bull. 48(3):484-485 (1993). Type: Sierra Leone, Loma, Jaeger 9390 (K, holotype!; M, iso!).

Bidens gledhillii T.G.J. Rayner, Phytologia 75(1):100 (1993). Type: Sierra Leone, Loma mountains, J.K. Morton & D. Gledhill SL. 1095 (WAG, holotype, n.v.; K, iso!), **synon. nov.**

B. sierra-leonensis is an erect perennial plant so far known from mountain grasslands in Sierra Leone, West Africa. In habit and several morphological features (e.g. foliar morphology, size and shape of phyllaries and achenes) it resembles *B. macroptera* (Sch. Bip. ex Chiov.) Mesfin, but differs from it in the smaller size of the capitulum, ray florets, lack of pubescence on phyllaries, triquetrous nature of the aristae, etc. Often the outer phyllaries in *B. macroptera* are wrinkled or once- to several-times constricted on the margins in the middle. *B. macroptera* is a perennial species confined to the Ethiopian highlands.

The thin inner phyllaries of both *B. sierra-leonensis* and *B. macroptera*, which are reflexed at full maturity of the capitulum to expose the achenes, are probably an adaptation for anemochory and may serve as additional evidence for the apparent morphological similarity between the two species. *B. camporum*, with which *B. gledhillii* has been compared by Rayner (1993b), has basally thickened inner phyllaries which consist of a mass of sclerotic parenchyma and collenchymatous tissue. This species has erect capitula, whose strongly indurate inner phyllaries are never reflexed at maturity, but remain erect keeping the mature achenes firmly enclosed within. In such cases the dispersal of fruits is apparently ballistic.

Thus, *B. gledhillii*, also from the same mountain in Sierra Leone and compared also with *B. borianiana* (Sch. Bip. ex Chiov.) Cufod., a species with comparatively lesser affinity to *B. sierra-leonensis*, is here considered synonymous with the latter mentioned species. Its closest phenetic similarity seems to be with *B. macroptera*.

Bidens diversa Sherff, Bot. Gaz. 76:159 (1923), Field Mus. Nat. Hist., Bot. Ser. 16:329, fig. 75/a, b, d-i (1937); Mesfin, Kew Bull. 48(3): 493 (1993); Rayner, Phytologia 75(2):152 (1993). Type: Angola, Mounyino, Antunes 315 (B†, holotype). Neotype: Angola, Huila, Lubango, A. Borges 167 (LISC, neotype, selected by Rayner (1992); M, P, PRE, SRGH, isoneotypes).

B. diversa Sherff subsp. *diversa* sensu Rayner, Phytologia 75(2): 155 (1993).

B. diversa Sherff subsp. *filiformis* (Sherff) T.G.J. Rayner, Phytologia 75(2): 156 (1993), **synon. nov.** Type: Zambia, Lake Chila, April 1936, Burt 6269 (F, holotype, n.v.; BM!, BR!, K!, iso.).

For further synonyms see Mesfin (1993:493) and Rayner (1993c: 155, 156).

As discussed in an earlier article (Mesfin 1993:494), *B. diversa* is composed of populations with variable morphology, i.e. variations usually occurring in the way the leaves are dissected, the size of phyllaries and the texture of the achenes. Some of these entities have earlier on been accorded specific status by Sherff (1931, 1939) and Merxmüller (1954). Recently, Rayner (1993c: 149) attempted to subdivide the species based on character states of the ray florets. The ray florets in *Bidens* are generally elliptic or oblong-elliptic and tapered at both ends. The apices are usually minutely 2-3-fid. Variations from this 'typical' shape are quite often encountered in many species, e.g. *B. prestinaria* (Sch. Bip.) Cufod. (cf. Mesfin 1984:53, fig. 25 e,f), *B. carinata* Cufod. ex Mesfin (cf. Mesfin 1984:91, fig. 45 c,d), *B. ugandensis* (S. Moore) Sherff (cf. Mesfin 1984:100-101, fig. 49 g and fig. 50 d), etc. Likewise, the apices of the ray florets are quite variably cut.

'*Bidens ruyigiensis*' T.G.J. Rayner, Phytologia 74(5):414(1993).

This entity, described as an annual plant, was published on the basis of the specimens Reekmans 5304 (Types: holo. C; iso. BR, MO, PRG) and Reekmans 1851 (Paratypes: BR, EA, MO), both from Burundi, and was compared with *B. burundensis* Mesfin. A photograph of Reekmans 5304 at Kew has just been examined thanks to the kind assistance of Dr. Nicholas Hind, R.B.G., Kew. This specimen, which probably represents an annual species, was tentatively determined in 1989 as "*Bidens* sp. cf. *B. zairensis* Lisowski" by one of us (M.T.), as it bears only young capitula with immature achenes. The other specimen, Reekmans 1851, was determined as *B. lineariloba* Oliv. (cf. Mesfin 1993:507), an annual

plant with widely divergent achenes that are quite unique among African species of *Bidens*.

While particularly Reekmans 5304 might probably represent a previously undescribed plant, the comparison of *B. ruyigiensis* with *B. burundiensis* is unwarranted, as the latter species is a perennial plant and morphologically unrelated. Lisowski (1991:169) cited Reekmans 5304 and 1851 under *B. praecox* Sherff. This name was relegated to synonymy under *B. taylori* (S. Moore) Sherff (cf. Mesfin 1993:472), a species so far known from low (i.e. 50 - 300(-700) m) grasslands and seasonally wet areas from Kenya and Tanzania.

It would have been more meaningful to also examine and annotate the specimens at Kew and compare *B. ruyigiensis* with *B. zairensis*, as these seem to have many morphological features in common. For descriptions of the latter species refer to Lisowski (1987:466) and Mesfin (1993:494). We hope that future workers on the genus will consider these notes and will unravel the true identity of *B. ruyigiensis*.

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NEW TRANSFERS TO *GRAPHISTYLIS* B. NORD. (SENECIONEAE)

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The genus *Graphistylis* B. Nord. was described in 1978 as a genus of the Senecioneae comprising six species endemic to Brazil (Nordenstam 1978). *Senecio* sect. *Dichroa* Cabr. was cited as a synonym. However, *S. dichrous* (Bong.) Schultz-Bip., based on *Cacalia dichroa* Bong. was not included, because of its doubtful status. This seemed to differ from all species of *Graphistylis* by its discoid capitula, and I had not had an opportunity to study the type specimen in the Leningrad Herbarium.

In 1992 Zardini described a new species of sect. *Dichroa*, viz. *Senecio serranus* Zardini (1992). She compared it to *S. dichrous*, which she also included in that section of *Senecio*. A photograph of the type of the latter (*Riedel s.n.* in LE) was available to her. These two species are both discoid, but are clearly distinct in a number of characters.

In spite of the discoid capitula, both species belong in my genus *Graphistylis*. They share the characteristic habit of *Graphistylis*, with shortly petiolate alternate leaves with reticulate venation and dentate or serrate margins, corymbose-paniculate synflorescences, narrowly campanulate involucre with uniseriate phyllaries and few calyculus bracts. The disc-floret lobes have a median resin duct, and the styles are provided with a characteristic median apical brush of hairs, and smaller lateral hair tufts. The other floral details are mainly 'senecioid', i.e. the stigmatic areas are separated by a narrow line, the filament collars are basally swollen with larger basal cells, but the endotheical tissue is at least partly polarized, not strictly radial as in most 'senecioid' genera.

I have studied material of *S. serranus* in the Stockholm Herbarium (S), viz. *Silva & Zelma s.n.*, Serra Capivari Grande, 18.VII.1986, which was cited, but not seen by Zardini. I can thus supplement Zardini's description of the cypselas with the following observations.

Cypselas narrowly elliptic-oblong, somewhat tapering to both ends, terete, 7--7.5 mm long, 1--1.5 mm broad, glabrous, light brown, with 10 darker narrow impres-

sed lines. Pappus bristles numerous, pluriseriate, persistent, white, finely barbelate.

The following new combinations are needed.

***Graphistylis serrana* (Zardini) B. Nord., comb. nov.**

Basionym: *Senecio serranus* Zardini, *Novon* 2: 282 (1992). - Type: Brazil, Paraná: Campina Grande do Sul, Serra Capivari Grande, 6.III.1969, *Hatschbach* 21212 (MBM holo; MO, US iso).

***Graphistylis dichroa* (Bong.) B. Nord., comb. nov.**

Basionym: *Cacalia dichroa* Bongard, *Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat.* 5: 40 (1840). - Type: Brazil, Minas Gerais, *Riedel s.n.* (LE holo).

With the inclusion of these two species in *Graphistylis*, the generic description is slightly amended to include also discoid species. The genus now comprises eight species, all confined to Brazil.

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